DEVELOPMENT OF LITHIUM AND LITHIUM-ION "ON-CHIP" MICROBATTERY

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The miniaturization of electronic components with submicron feature sizes, and the integration of millions of transistors on a "chip", has not been accompanied by a similar miniaturization of batteries. The need for micro-size energy sources is evident when taking into account the vast possibilities introduced by both microelectronics and the newer micro-electro-mechanical system (MEMS) technologies. Battery capacity is directly proportional to the area and thickness of the thin-film (anode-electrolyte-cathode) layers that form it. Thin-film planar lithium-secondary-battery research began more than a decade ago, mainly by Bates et al. [1]. An innovative way to increase the capacity is to increase the surface-to-volume ratio of the substrate, upon which the layered thin-film structure is deposited [2]. This can be achieved by etching the silicon to form an array of through-variable-shape holes. A thin-film battery with conformal layers deposited inside the holes and on both flat surfaces, can result in a theoretical increase in capacity to about 10,000 μAh per 1 cm^2 of original substrate.

In this work, we describe an effective method for depositing a highly adhesive 5 to 20μm thick copper coating on silicon, and a procedure of electrochemical preparation of copper sulfide. A modified LiI-$P(EO)_n$ electrolyte for Li/composite polymer electrolyte (CPE)/metal sulfide batteries was tested and showed high ionic conductivity and stable Li/CPE interfacial resistance. Copper and cobalt sulfide as possible cathode materials for ultra-thin Li/polymer electrolyte on-chip microbatteries were characterized by SEM (Fig. 1), XRD and electrochemical methods. A 1cm^2 Li/CPE/copper sulfide cell went through over 50 reversible cycles with a capacity loss of 1.45%/cycle.

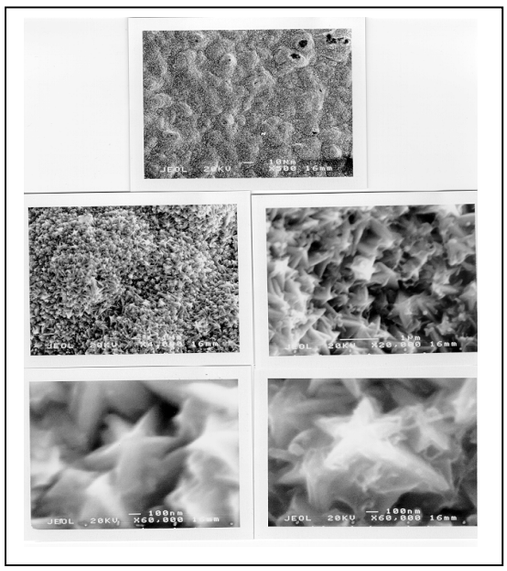

Fig. 1 SEM micrographs of electrochemically produced copper disulfide on copper coated silicon wafer

References

1. J.B. Bates, N. J. Dudney, G.R. Gruzalski et. al., J. Power Sources, **43**, 127 (1993).
2. Micro-electrochemical energy storage cell", M. Nathan, D. Haronian and E. Peled, U.S. Patent No. 6,197,450.